

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants : Moy et al.
Serial No. : To be assigned
Filed : April 20, 2001
For : Process for Producing Single Wall Nanotubes Using Unsupported
Metal Catalysts and Single Wall Nanotubes Produced According to
this Method
Group Art Unit : To be assigned
Examiner : To be assigned

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PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Please amend the instant application as follows.

IN THE CLAIMS:

Please cancel claims 1-23.

Please add the following new claims 24-39.

24. A method for producing single wall carbon nanotube products comprising the
steps of:

- (a) providing a CO gas stream;
- (b) providing a gaseous catalyst precursor stream comprising a gaseous catalyst
precursor that is capable of supplying atoms of a transition metal selected from the group

consisting of Fe, Co, Mn, Ni, and Mo, said gaseous catalyst precursor stream being provided at a temperature below the decomposition temperature of said catalyst precursor;

(c) heating said CO gas stream to a temperature that is (i) above the decomposition temperature of said catalyst precursor and (ii) above the CO decomposition initiation temperature, to form a heated CO gas stream; and

(d) mixing said heated CO gas stream with said gaseous catalyst precursor stream to rapidly heat said catalyst precursor to a temperature that is (i) above the decomposition temperature of said catalyst precursor, (ii) sufficient to promote the rapid formation of catalyst metal atom clusters and (iii) sufficient to promote the initiation and growth of single wall nanotube by the CO decomposition reaction, to form a suspension of single wall carbon nanotube products in the resulting gaseous stream.

25. The method of claim 24 further comprising the step of separately recovering said single wall carbon nanotube products from said resulting gaseous stream.

26. The method of claim 24 wherein said catalyst precursors is a metal-containing compound of a metal selected from the groups consisting of molybdenum, iron, nickel, cobalt, and manganese.

27. The method of claim 26 wherein said metal-containing compound is a metal carbonyl.

28. The method of claim 27 wherein said metal carbonyl is selected from the group consisting of $\text{Fe}(\text{CO})_5$ or $\text{Mo}(\text{CO})_6$ and mixture thereof.

29. The method of claim 24 wherein said CO gas stream is provided at a pressure of about 0 p.s.i.g. to about 100 p.s.i.g.

30. The method of claim 24 wherein said gaseous catalyst precursor stream is supplied in a CO gas stream.

31. The method of claim 30 wherein the partial pressure of said catalyst precursor in said high pressure CO gas stream is from about 0.25 Torr to about 100 Torr.

32. The method of claim 24 wherein said gaseous catalyst precursor stream is supplied at a temperature in the range of from about 70°C to about 80°C.

33. The method of claim 24 wherein said CO gas stream is heated to a temperature in the range of from about 400°C to about 1300°C.

34. The method of claim 24 wherein said catalyst precursor is heated to a temperature in the range of from about 400°C to about 1300°C.

35. The method of claim 25 wherein said single wall carbon nanotube products are substantially free of solid contaminants other than catalyst atoms.

36. The method of claim 25 wherein said single wall carbon nanotube products have a tube diameter about 1 nm.

37. The method of claim 24 further comprising the step of controlling the diameter of the single wall carbon nanotube products recovered by controlling the catalyst cluster size at the time the growth reaction is initiated.

38. The method of claim 37 wherein said catalyst cluster size is controlled by controlling the temperature or controlling the vapor pressure of the gaseous catalyst precursor.

39. A single wall carbon nanotube product made by the process comprising the steps of:

- (a) providing a CO gas stream;

(b) providing a gaseous catalyst precursor stream comprising a gaseous catalyst precursor that is capable of supplying atoms of a transition metal selected from the group consisting of Fe, Co, Mn, Ni, and Mo, said gaseous catalyst precursor stream being provided at a temperature below the decomposition temperature of said catalyst precursor;

(c) heating said CO gas stream to a temperature that is (i) above the decomposition temperature of said catalyst precursor and (ii) above the CO decomposition initiation temperature, to form a heated CO gas stream;

(d) mixing said heated CO gas stream with said gaseous catalyst precursor stream to rapidly heat said catalyst precursor to a temperature that is (i) above the decomposition temperature of said catalyst precursor, (ii) sufficient to promote the rapid formation of catalyst metal atom clusters and (iii) sufficient to promote the initiation and growth of single wall nanotube by the CO decomposition reaction, to form a suspension of single wall carbon nanotube products in the resulting gaseous stream; and

(e) separately recovering said single wall carbon nanotube products from said resulting gaseous stream, wherein said single wall carbon nanotube products are substantially free of solid contaminants other than catalyst atoms and have a tube diameter about 1 nm.

REMARKS

Applicants have cancelled claims 1-23 and have added new claims 24-39 which, with a few minor changes, were virtually copied from claims 1, 3, 8-11, 13-14, 16-17, 21, 24, 26, and 28-30 of the Smalley PCT/US99/25702 (hereinafter, Smalley '702 PCT) for the purpose of provoking an interference with Smalley U.S. patent applications claiming the same subject matter. In this regard, Applicants have also submitted a 37 C.F.R. 1.604(a) REQUEST FOR

AN INTERFERENCE WITH AN APPLICATION(S) and a PRELIMINARY REMARKS
UNDER 37 C.F.R. 1.604(b).

Applicants believe that claims 24-39 are patentable in all respects and submit herein as Exhibit A a claim chart showing various examples of written description support from the Applicants' specification.

In view of the foregoing remarks, applicants respectfully requests consideration of the above-identified application, preliminary amendment, preliminary remarks, and request for interference. Early and favorable declaration of an interference between the present application and any of the Smalley U.S. applications identified in the Applicants' request for an interference is respectfully requested.

If there are any questions, the Examiner is asked to contact the Applicants' attorney. If there are any additional charges, please charge them to the firm deposit account no. 50-0540.

Respectfully submitted

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